## Amplitudes

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Modern amplitude methods have made a huge impact on our understanding of quantum field theory and our ability to make precise predictions for physical observables. Their remarkable mathematical structure has led to new results in an enormous range of subjects from gravitational waves, condensed matter systems and collider experiments.

The research activity of the Amplitudes project deals with the computation of scattering amplitudes which are of interest in Collider Physics and in Gravitational-Wave Physics. In particular, in the LNF node we dealt with:

- developing a scheme for the computation of cross sections at next-to-next-to-leading order (NNLO) accuracy in the strong coupling constant  $\alpha_s$  and beyond in a process-independent way <sup>1</sup>), exploiting the universality of the infrared divergences;
- exploring common patterns in the computation of scattering amplitudes in gauge theories, analysing them in the Regge limit <sup>2</sup>;
- computing the emission of gravitational waves from a binary system of massive compact objects through the use of scattering amplitudes and effective field theories 3).

## News from the LNF node

- Since 2024, we have had a junior postdoc fellowship with research project "Scattering amplitudes and modelling of gravitational wave emissions", for which Dr. Francesco Alessio has been selected.
- From October 2025, we will have a senior postdoc fellowship with research project "Developing a scheme for high-precision computations of cross sections at hadron colliders", for which Dr. Ming-Ming Long has been selected, who is currently affiliated at the Institute for Theoretical Particle Physics of the Karlsruhe Institute of Technology.
- In 2024, V. Del Duca supervised the theses of two MSc students of University of Roma "La Sapienza": Andrea De Simone with research project "A new Gravitational Self-Force Approach with Scattering Amplitudes", and Damiano Barcaro with research project "Scattering Waveforms for Kerr Black Holes from the Soft Expansion".
- In 2024, V. Del Duca started supervising the PhD project of Emanuele Rosi of University of Roma "La Sapienza" with research project "Modelling waveforms of binary systems of massive compact objects with gravitational wave emission".
- In 2024, V. Del Duca organised at LNF two workshops: "High Luminosity LHC and Hadron Colliders" held on 1-4 October 2024, and "FCC-ee and Lepton Colliders" held on 22-24 January 2025, both in the context of the INFN initiatives for the European Strategy for Particle Physics (ESPP) Update 2025-2026.

## References

- V. Del Duca, C. Duhr, L. Fekeshazy, F. Guadagni, P. Mukherjee, G. Somogyi, F. Tramontano and S. Van Thurenhout, "NNLOCAL: completely local subtractions for color-singlet production in hadron collisions," [arXiv:2412.21028 [hep-ph]].
- 2. E.P. Byrne, V. Del Duca, E. Gardi, Y. Mo, J.M. Smillie, "Factorisation of tree-level QCD amplitudes using a minimal set of lightcone variables," to appear soon.
- 3. D. Akpinar, V. Del Duca, R. Gonzo, "The spinning self-force EFT: 1SF waveform recursion relation and Compton scattering," to appear soon.